Decadal variability of tropical TOA radiation budget from ERBE/ERBS and the GFDL climate model.

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CERES Science Team Meeting
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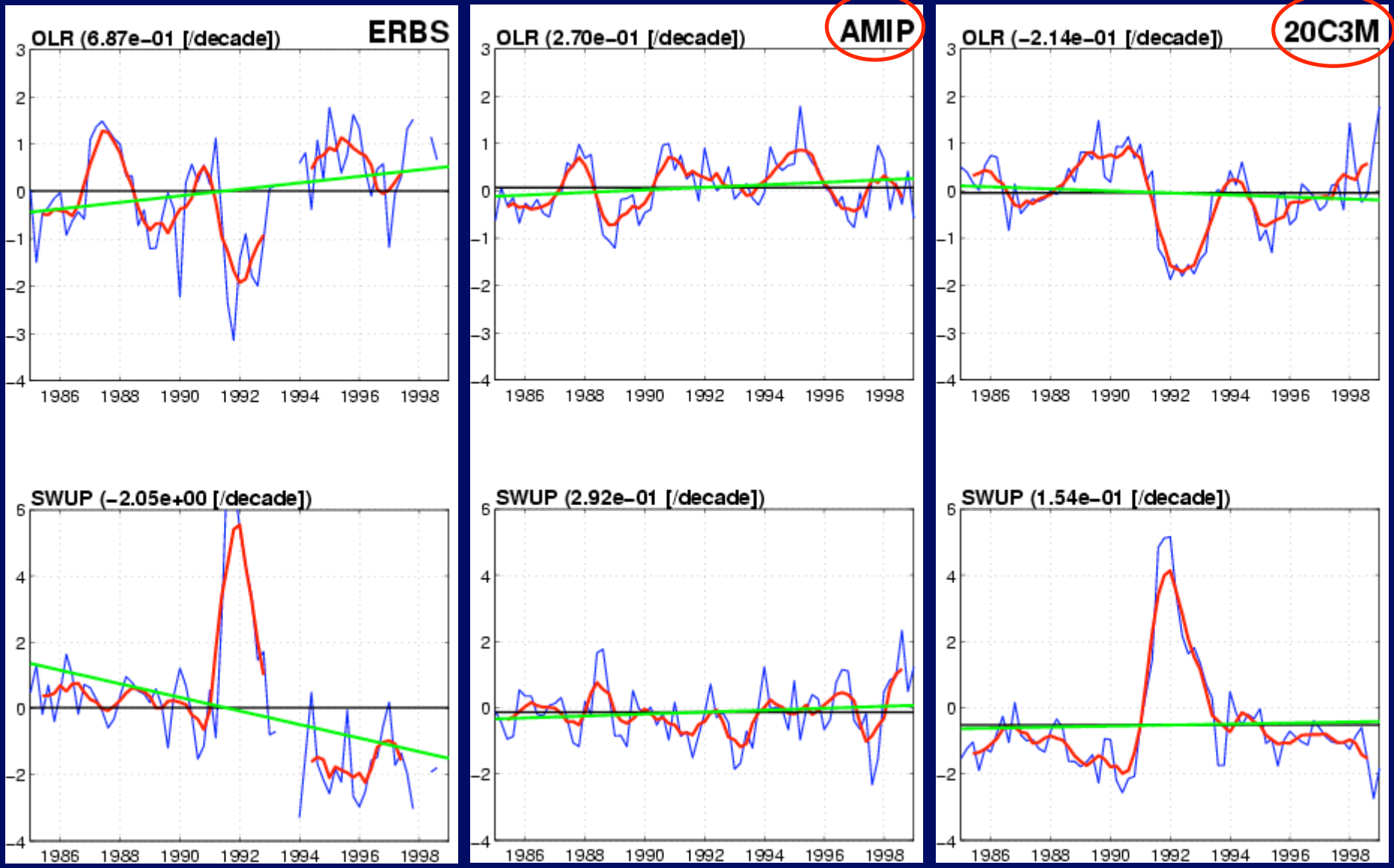
Central Questions

- Are *tropical mean* changes in TOA radiative fluxes reproducible by GCMs which incorporate forcings like greenhouse gases, volcanic eruptions, solar variability, etc?
- What are the *spatial patterns* of change of TOA fluxes in the tropics? Do these patterns contain information about the physical mechanisms responsible for the changes?

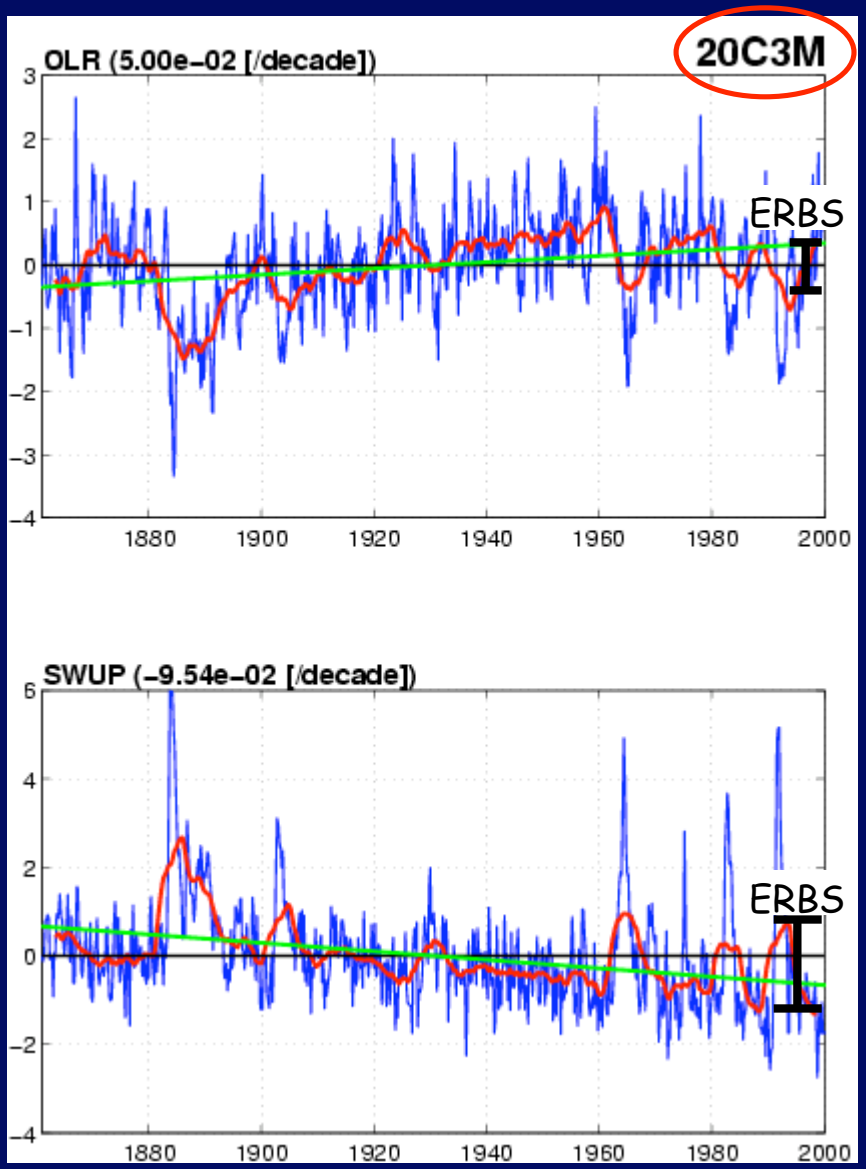
Data

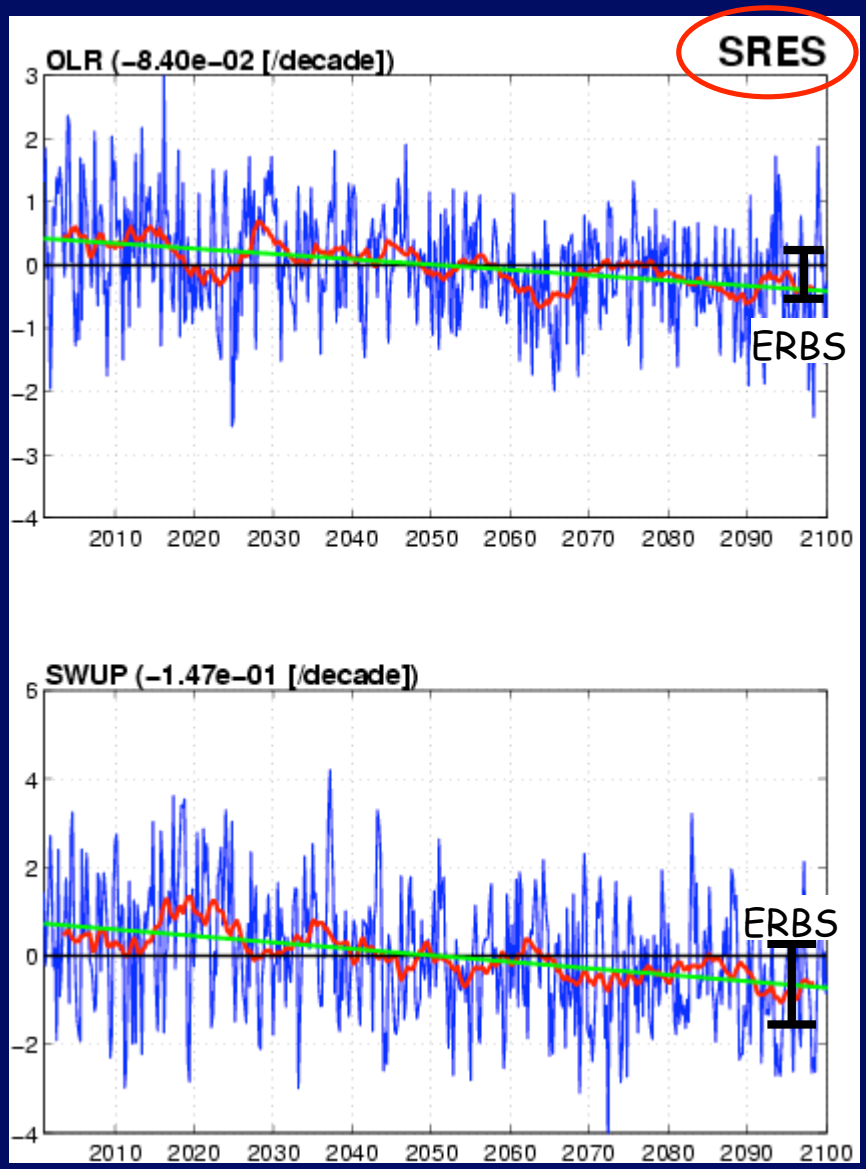
- **ERBE/ERBS NS WFOV** (1985-1999)
- **GFDL Simulations**
  - **AMIP: 1980-2004** (4 members)
    Prescribed SSTs and sea-ice.
  - **20C3M: 1860-2000** (3 members)
    Coupled, GHG forcing, volcanic eruptions, solar variability, etc.
  - **SRES: 2001-2100**
    Coupled, *only* GHG forcing.

Tropical Mean (20S-20N): 1985-1999

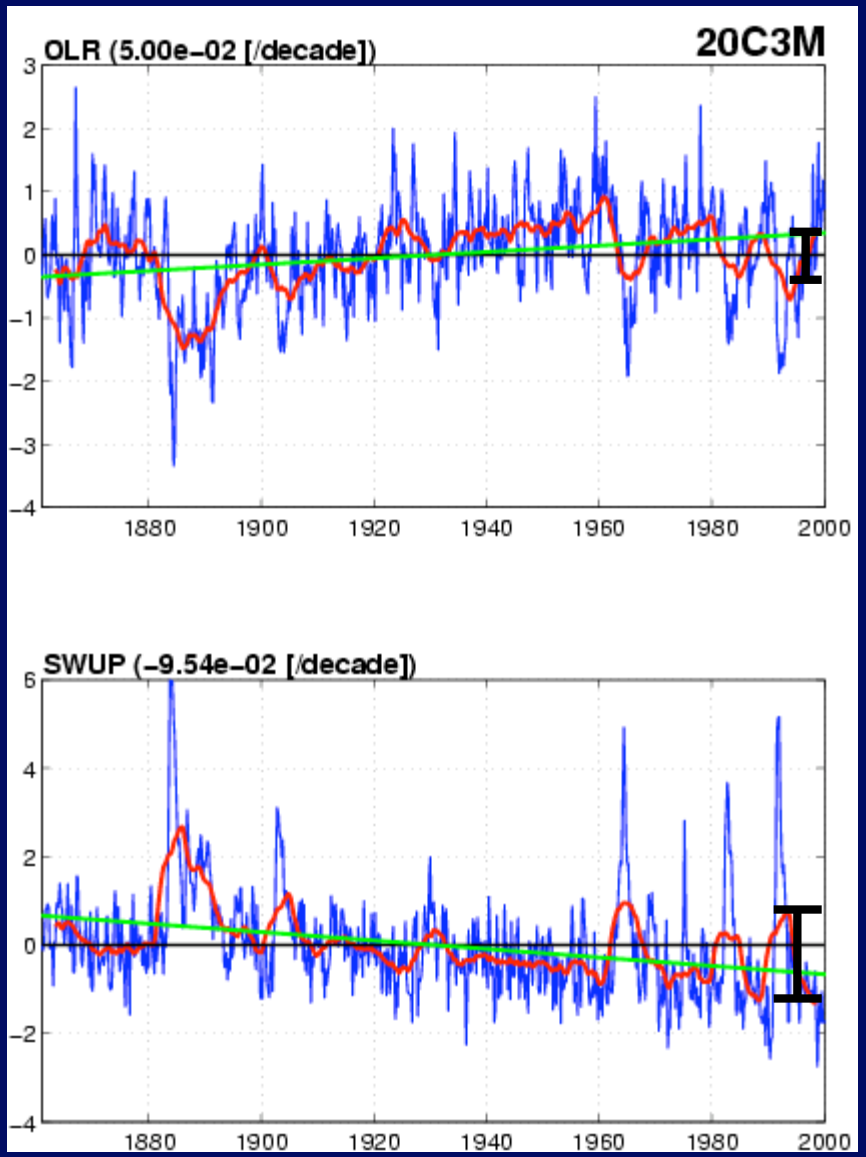


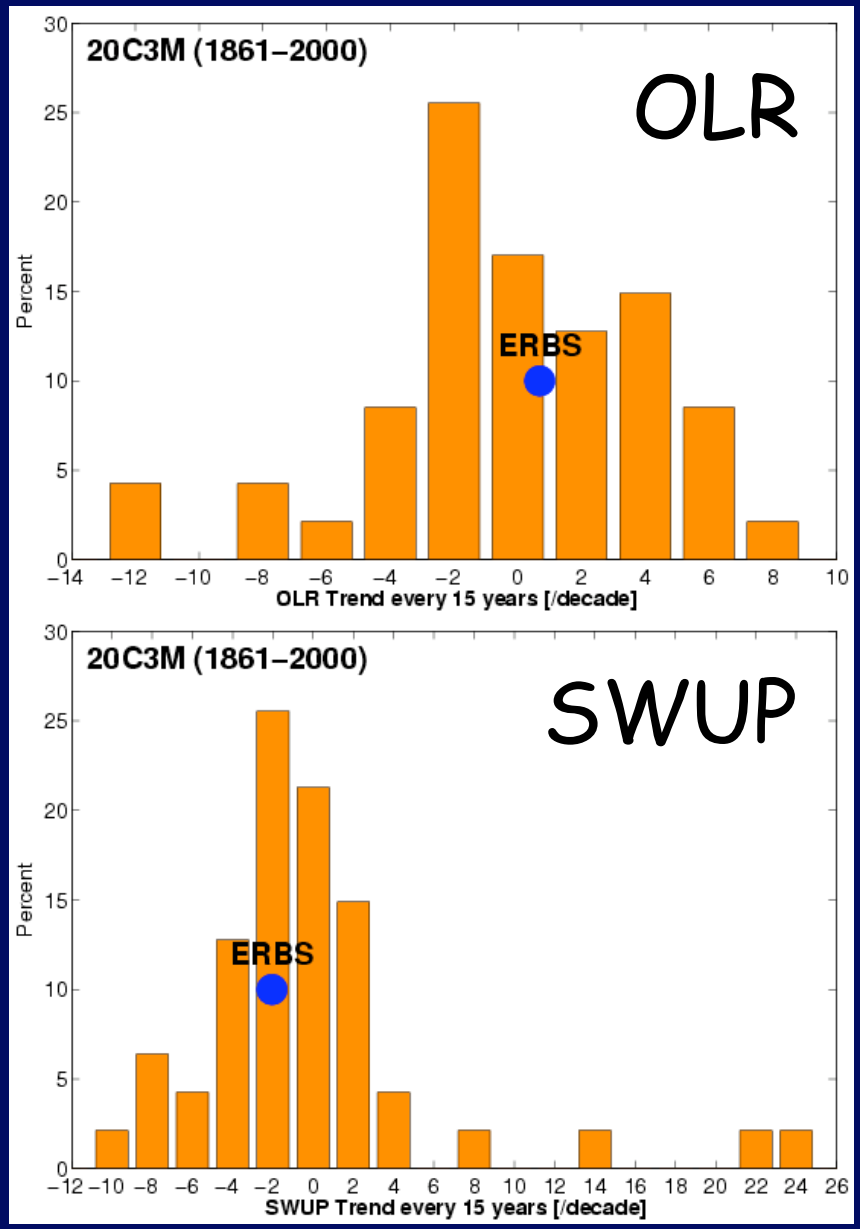
Tropical Mean (20S-20N)





Tropical Mean: 15 year trends

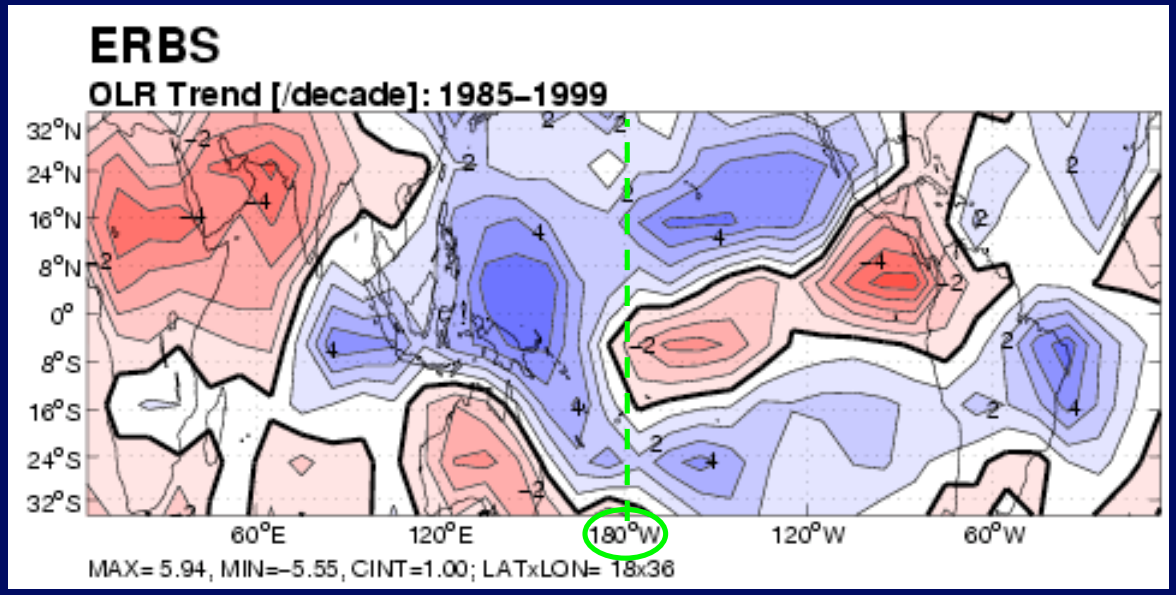


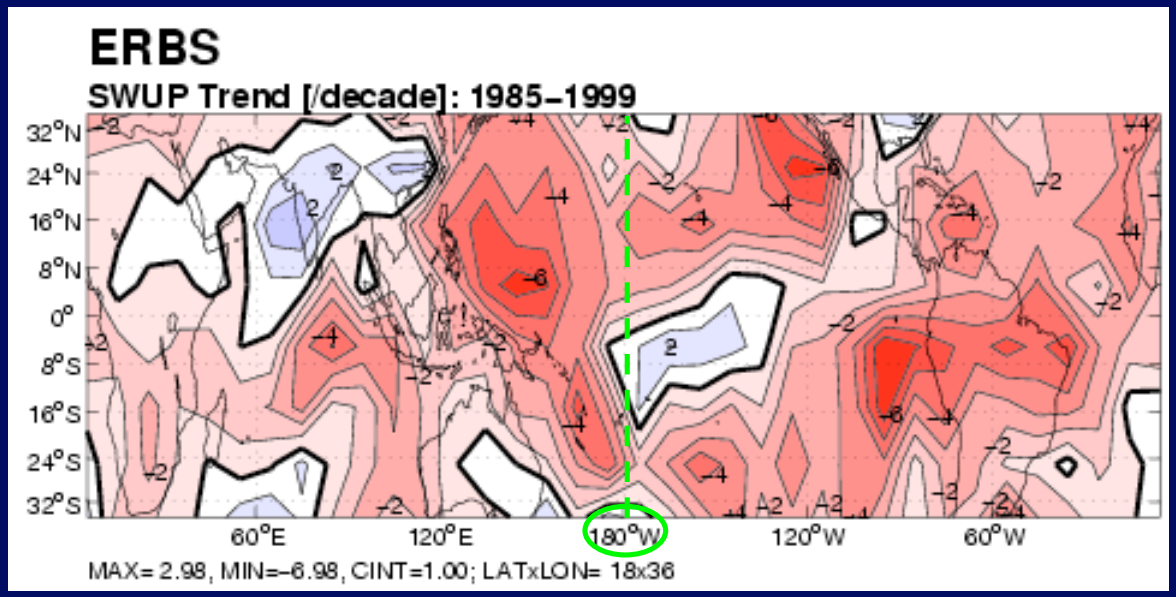


Summary

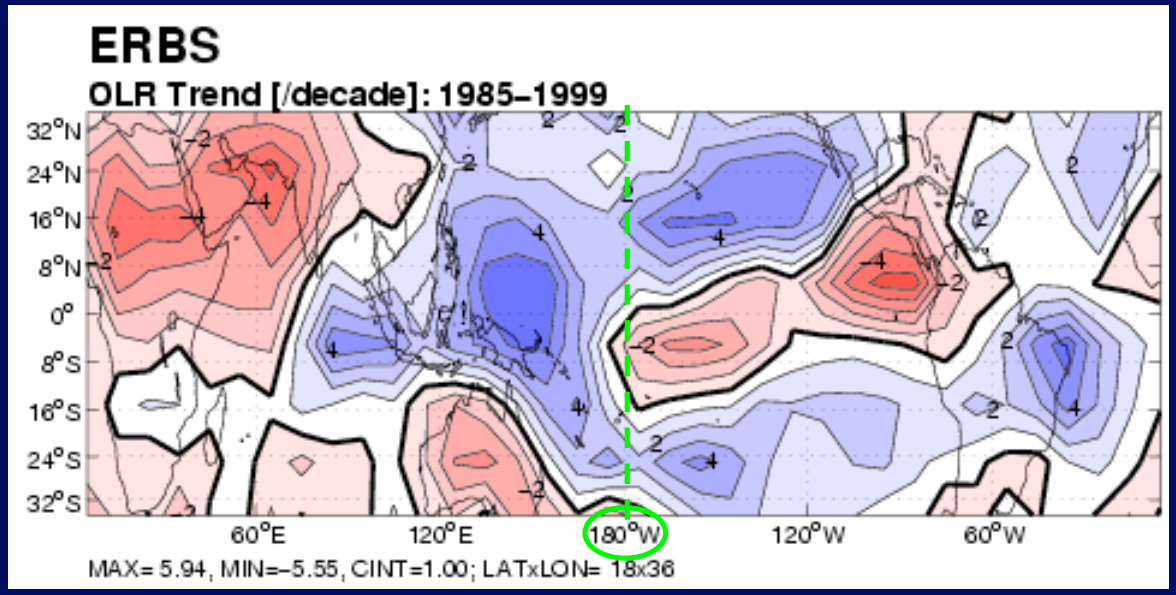
- AMIP and 20C3M simulations show no significant trends in tropical mean TOA fluxes for the period 1985-1999 (also *Wong et al.*)
- Long-term trends in tropical mean TOA fluxes are found in GCMs forced by GHG only.
- ERBS-like 15-year trends are reproducible by GFLD 20C3M both in OLR and SW TOA fluxes.

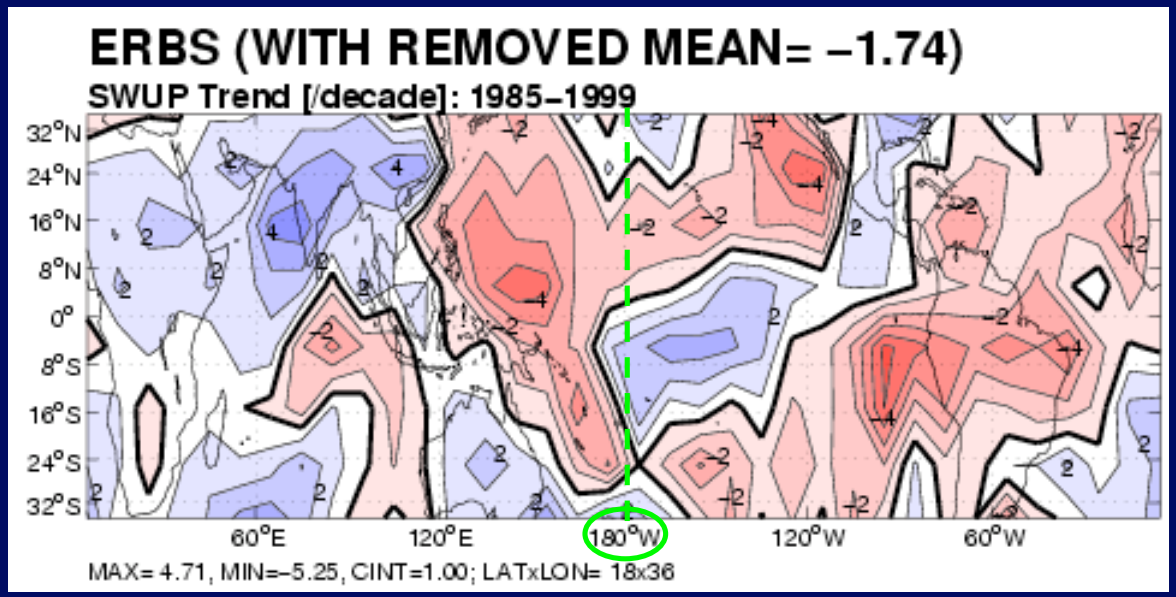
ERBE/ERBS Trends





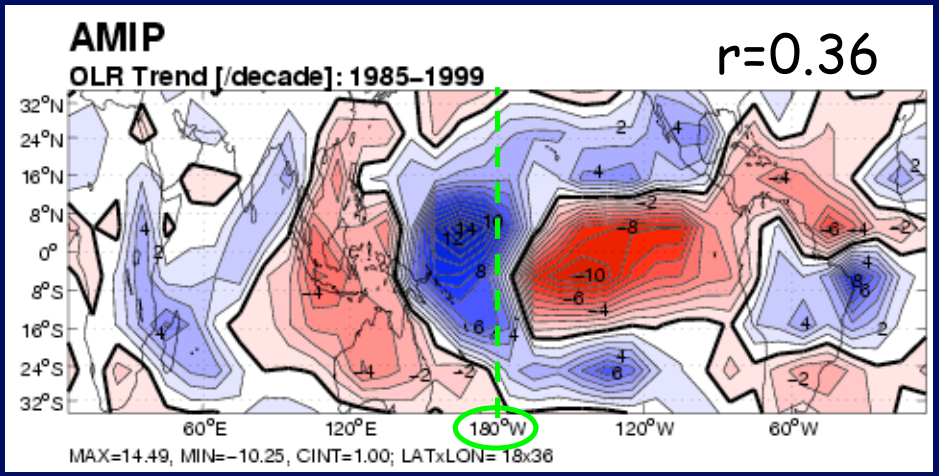
ERBE/ERBS Trends (cont.)

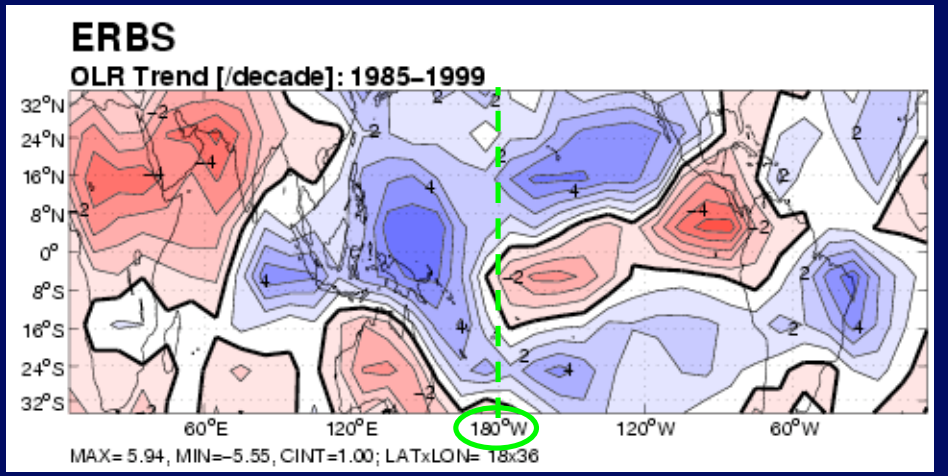


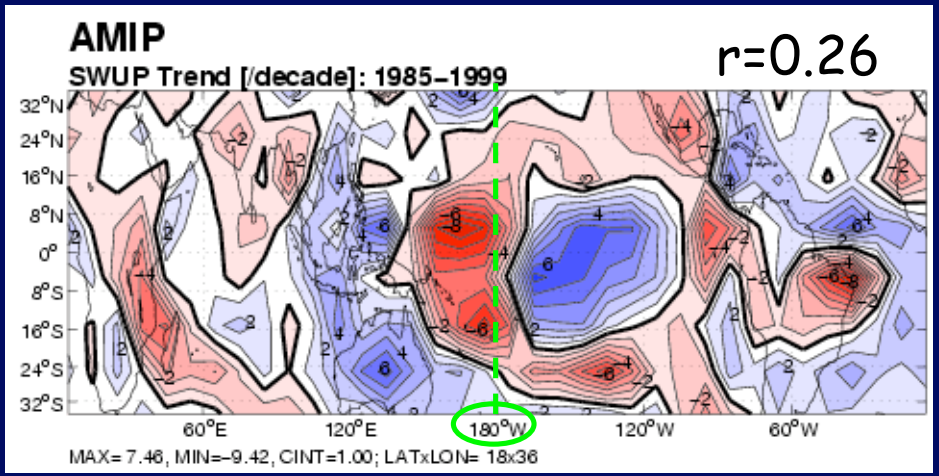


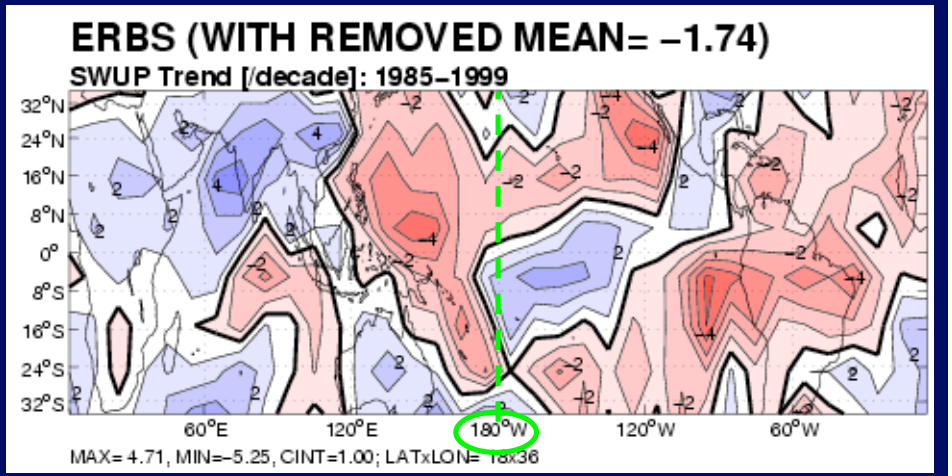
Removed Tropical Mean

AMIP vs. ERBS



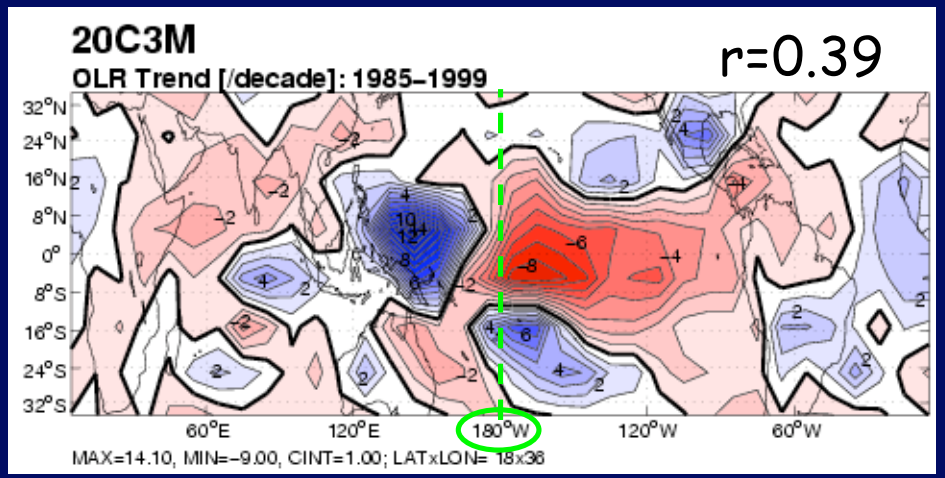


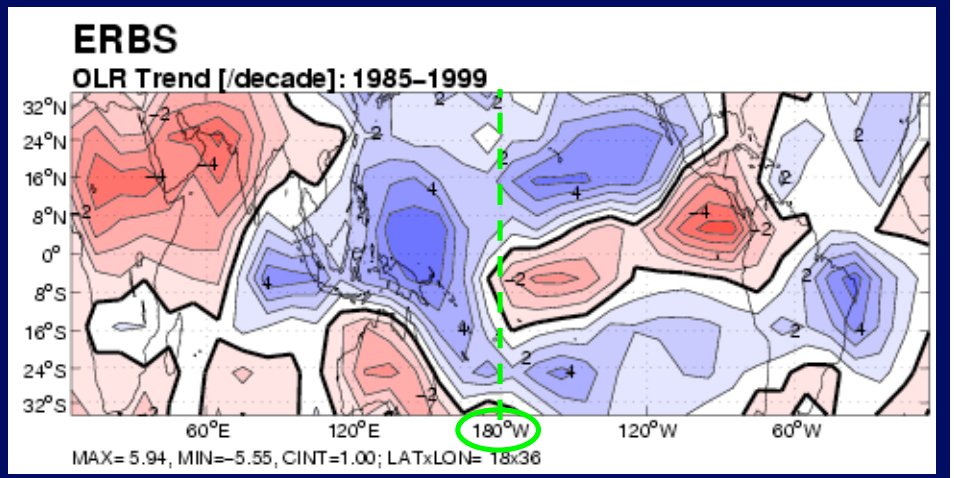


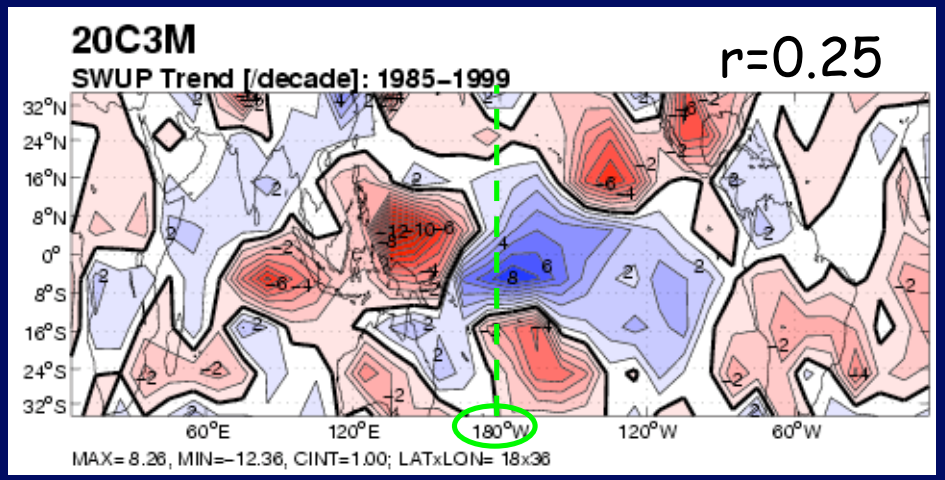


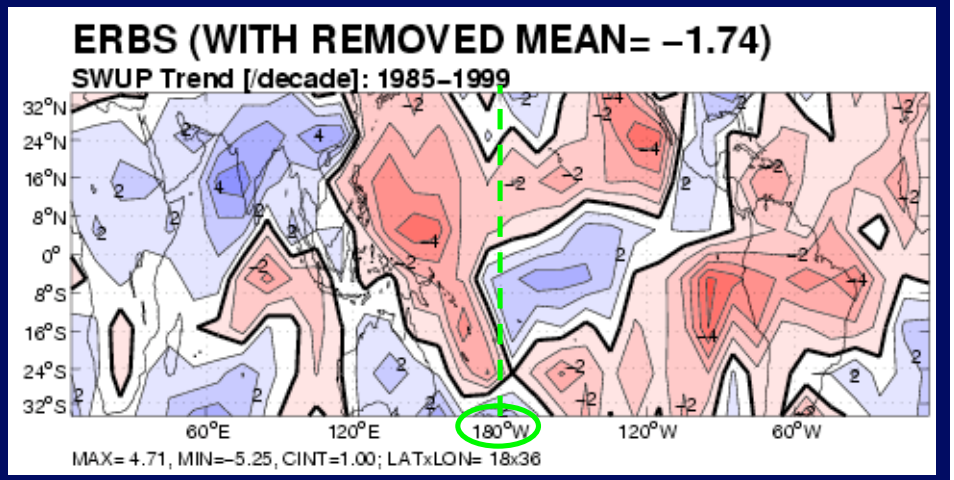
Trend amplitude ~2-3 times larger in *models*

20C3M vs. ERBS

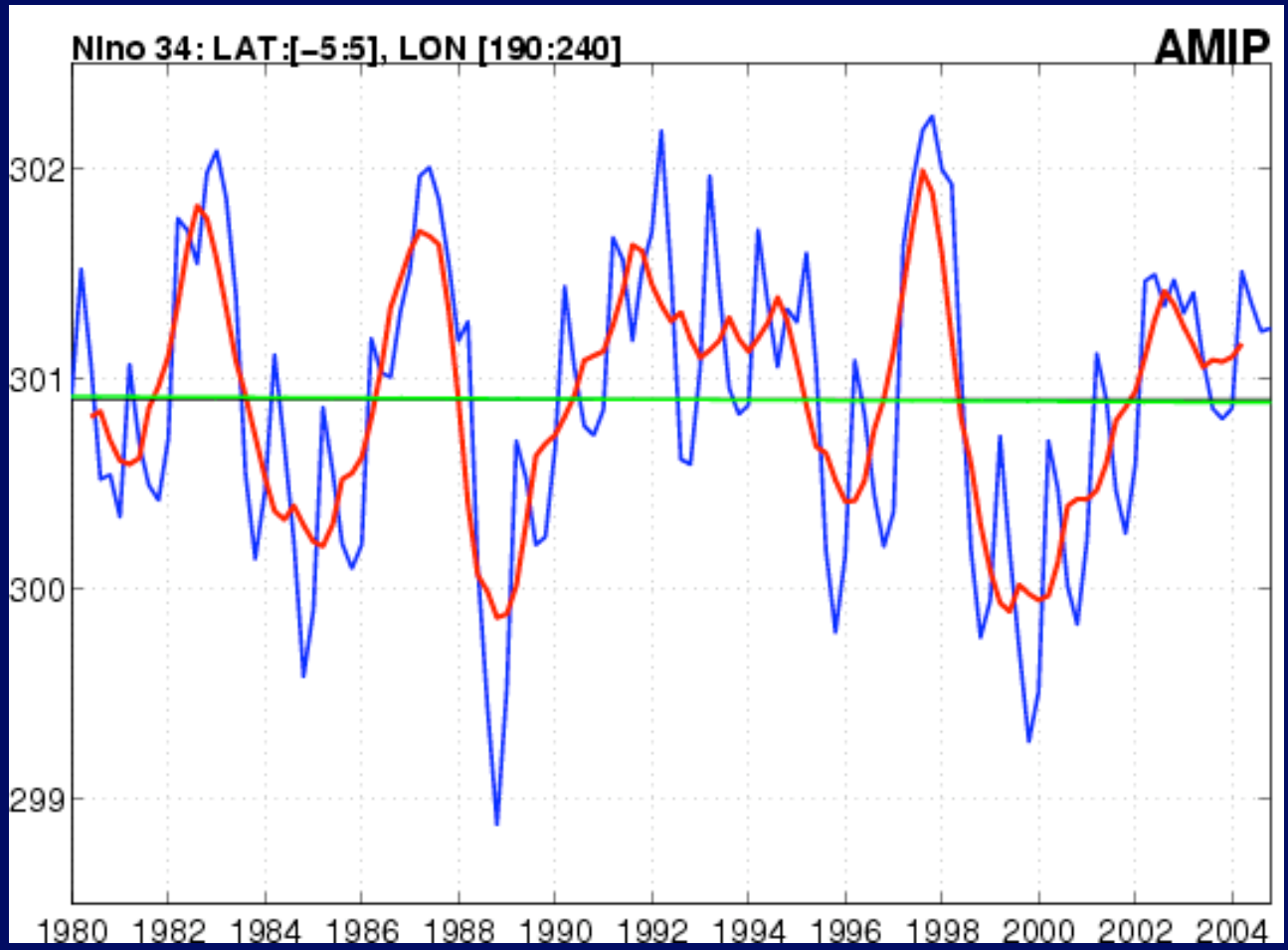




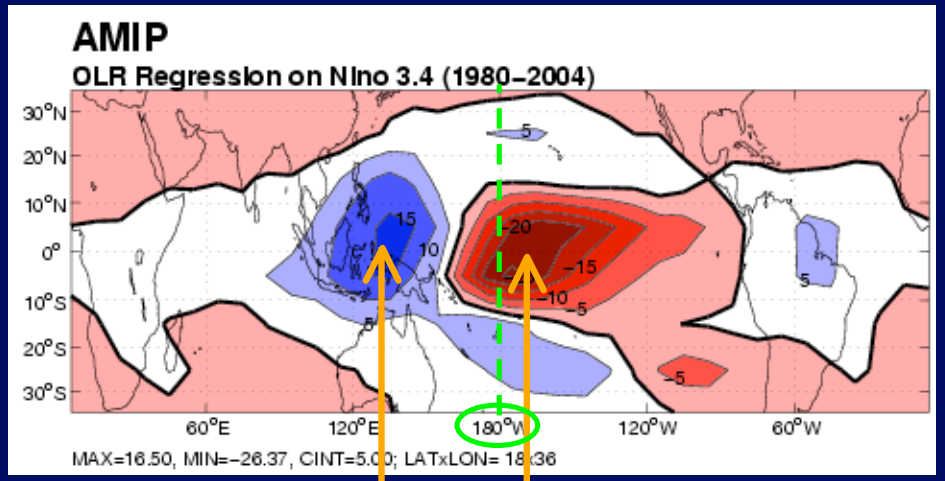


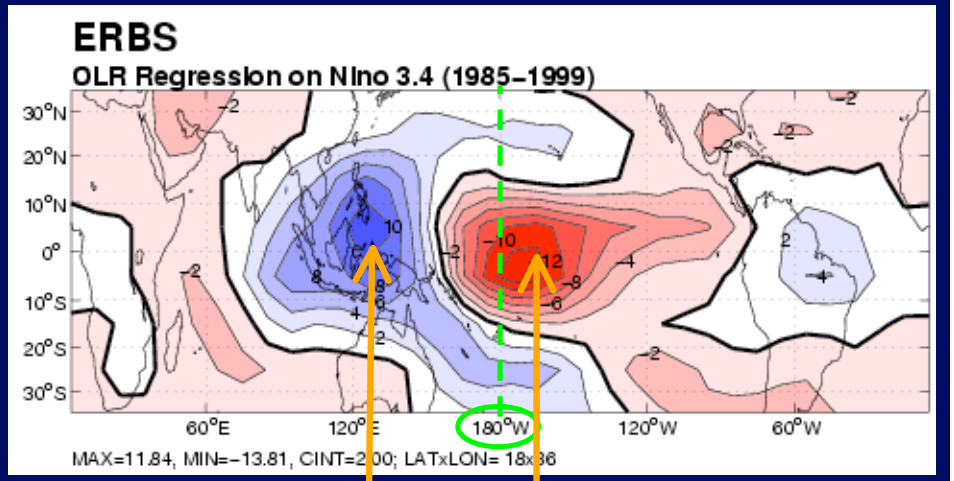


Niño 3.4


NIno 34: LAT:[−5:5], LON [190:240]
AMIP
302
301
300
299
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004

AMIP and ERBS
Regression on Niño 3.4



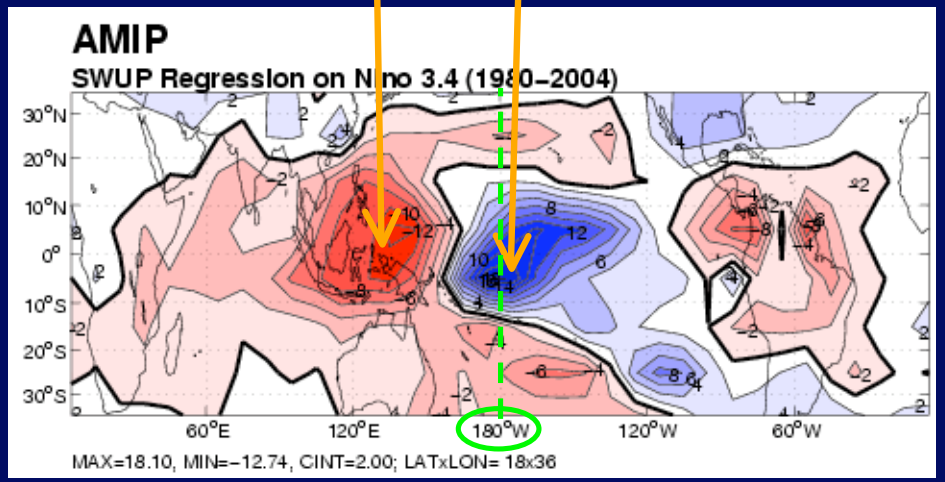


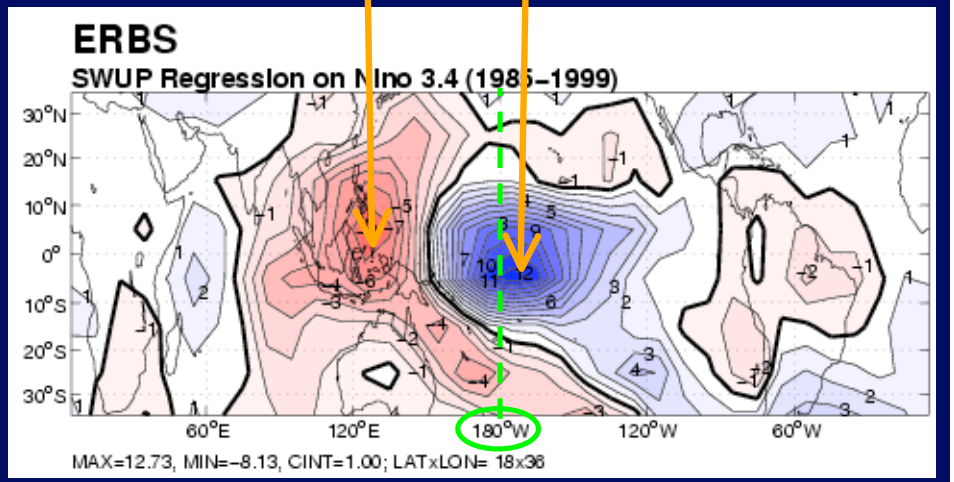
+15 -20

-12 +16

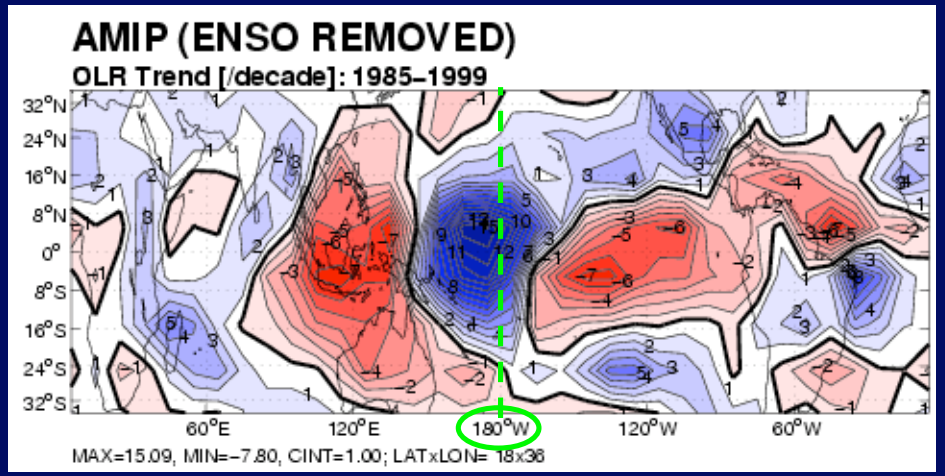
+10 -12

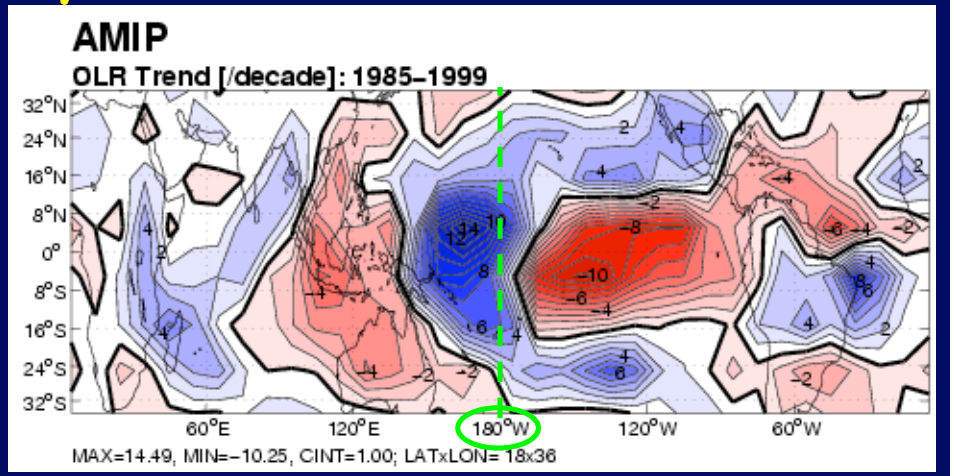
-7 +10

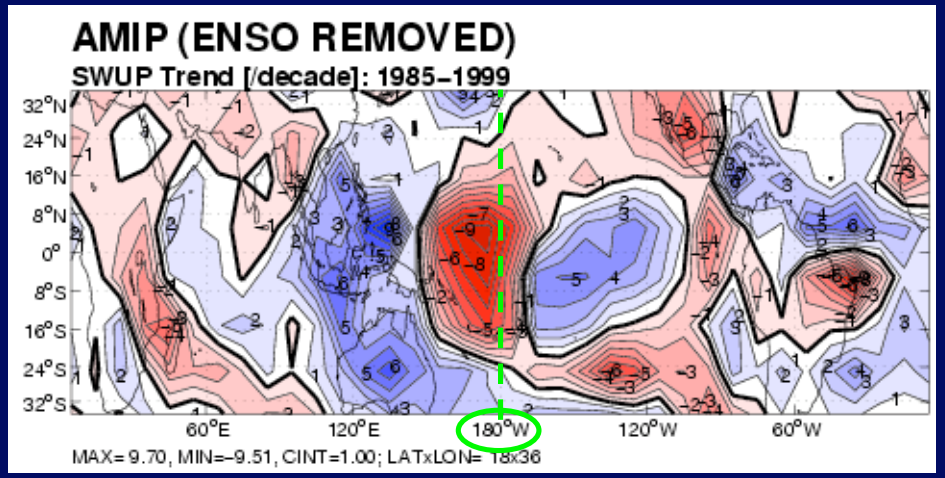


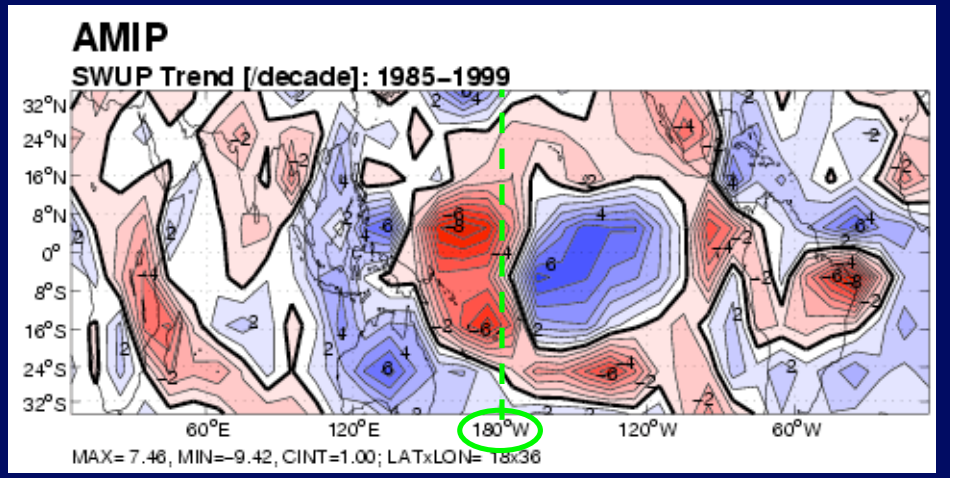


AMIP Trends
(ENSO Linearly Removed)









Summary

- Spatial patterns of trends show zonal shifts (i.e. ENSO-like), in observations and models.
- Regional trend magnitudes are larger (~2-3 times) in models. Is ENSO responsible for this *pattern* discrepancy?
- Cloud signal of ENSO is larger in models. However, *linear* effect of ENSO cannot explain differences.
- Non-linear effects of ENSO may still be relevant (nature of variables of interest *is* non-linear)

Conclusions

- GFDL GCM is able to reproduce ERBS-like 15-year *tropical mean* trends when forced with GHG, volcanoes, solar variability, etc. However, *not* the specific trend over the 1985-1999.
- There are significant long-term decreasing trends in TOA *tropical mean* fluxes in 21st century GHG simulations, which are comparable to ERBS.
- SST-only and GHG+Volcanic forced simulations show similar *patterns* of TOA tropical changes to ERBE/ERBS (patterns may not be robust, though)
- Spatial *patterns* of changes are ENSO-like (i.e. zonal shifts), however ENSO cannot *linearly* account

Future Work

- Examine longer period of satellite data to address robustness of trend signal and pattern.
- Use control simulations with no external forcings to test whether internal variability of GCMs can reproduce 15 year ERBS-like trends.
- Analyze AMIP and 20C3M simulations from other models to test results for dependence on specific GFDL model.
- Non-linear effects of ENSO:
  - Nonlinear statistical techniques (PCA, CCA, etc.)
  - Analysis of composites

The End